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ABSTRACT

Many have argued for the importance of numeracy, yet little is known about the opportunities for numeracy available to people in their daily lives. In this study, characteristics of rational numbers in magazines written for children, teenagers, and adults were analyzed and compared. Analysis indicated that difficult mathematical concepts that appear in the media such as fractions, percents, and averages are much more prevalent in adults' magazines than in those written for children and teenagers. Adults are often presented with rational numbers that are related to each other. Numbers in teenagers' texts do not appear to provide a transition to those found in adults' texts, despite the fact that through formal schooling teenagers have encountered all the mathematical concepts that are frequently found in adults' texts. Implications for preparing students for the numeracy demands of everyday life are discussed. An appendix contains the coding scheme used in the study. Contains 27 references. (Author/MKR)

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Numeracy as Cultural Practice: An Examination of Numbers in Magazines for Children, Teenagers, and Adults

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Abstract

Many have argued for the importance of numeracy, yet little is known about the opportunities for numeracy presented to people in their daily lives. In this study, we analyzed and compared the characteristics of rational numbers in magazines written for children, teenagers, and adults. Our analysis indicates that difficult mathematical concepts that appear in the media such as fractions, percents, and averages are much more prevalent in adults' magazines than in those written for children and teenagers. Adults are often presented with rational numbers which are related to each other. Numbers in teenagers' texts do not appear to form a transition to those found in adults' texts, despite the fact that through formal schooling teenagers have covered all the mathematical concepts that are frequently found in adults' texts. Implications for preparing students for the numeracy demands of everyday life are discussed.

Numeracy as Cultural Practice: An Examination of Numbers in Magazines for Children, Teenagers, and Adults

Numbers are pervasive in our daily lives. They are used to acquaint us with facts, and to persuade us of a writer's point of view. For example, arguments over the merits of regulating hazardous waste or mandatory AIDS testing are frequently supported with numbers such as percents and averages. The ability to understand and interpret arguments that hinge on numbers is essential for evaluating many of the claims that people encounter in their daily lives in advertisements, forecasts and public policies, and thus for becoming intelligent consumers who can make informed decisions (Kobitz, 1981; National Council of Teachers of Mathematics, 1989; Paulos, 1988; Steen, 1991; Willis, 1990).

In addition to interpreting numbers, people often have to perform calculations and estimate quantities in their daily lives; shopping, finance, and cooking are among the activities which require facility with numbers. Number skills are also essential in the workplace, and most jobs today require employees to work with basic number concepts and to apply higher-order reasoning about quantities (Carnevale, Gainer, & Meltzer, 1990; SCANS, 1991; Steen, 1991). All of these activities, comprehending and interpreting numbers, calculating, and estimating, fall under the heading of "numeracy." Numeracy has been defined as those mathematical skills that "enable an individual to cope with the practical demands of everyday life" (Cockcroft, 1982).

Although little research has been carried out under the heading of "numeracy," research on "quantitative literacy" makes some headway in

revealing people's skills at number manipulation with everyday materials. Kirsch, Jungeblut, Jenkins & Kolstad (1993) conducted a widescale national study of the quantitative literacy skills (skills dealing with printed numbers) of American adults using measures developed in a previous study (Kirsch & Jungeblut, 1986). The tasks varied in the extent to which numbers were embedded in the texts, the amount of irrelevant information included, the number of operations required to perform the task, and the degree of prior knowledge required. The easiest item consisted of adding two numbers on a bank deposit statement, and the most difficult item was calculating the total interest charges on a ten-year home equity loan. The researchers found that the majority of adults could adequately perform tasks at the lower levels of the quantitative literacy scale, but had difficulty with tasks of moderate or advanced complexity. This means that they could perform calculations which required few sequential operations, little prior knowledge, were carried out on numbers that were made explicit in texts, and which did not require an inference to be made about which type of operation to apply to the numbers. However, only one-fifth of the adults performed at the two highest levels of quantitative literacy. Kirsch et al. concluded that the most salient finding of their survey is that so many adults performed in the lowest levels on the literacy scales, and that this perhaps makes it challenging for them to pursue goals involving job advancement, consumer decision making, and citizenship. Most adults who were assessed were not fully quantitatively literate in the sense of the skills needed to function in a technologically advanced society.

The study described above explored the extent to which American adults can "do things" with numbers, a key aspect of numeracy. In addition to such skills, we suggest that numeracy also includes the interpretation of printed numbers for the sole purpose of acquiring information. This is similar to what Resnick (1990) has called "informational literacy," in which people read in order to acquire information, in contrast to "useful literacy," which involves "the use of written texts to mediate action in the world" (p. 176). "Informational numeracy" then, would include the interpretation of numbers in different kinds of texts: prose, advertisements, graphs and tables. This information may be used at a later time in discussions or to make decisions, but no immediate action is called for.

Resnick (1990) proposes that shifting from a view of literacy as a competency or ability to that of a set of cultural practices people engage in changes the focus of questions to include the study of the characteristics of texts that people typically read, and how their characteristics facilitate particular forms of literate practice. A similar point can be made with respect to numeracy, and rather than beginning our investigation of numeracy by asking what kinds of knowledge and skills numerate people carry around "in their heads," we instead chose to examine characteristics of numbers in everyday texts, and to infer from these characteristics the cognitive demands that will be placed on people when they encounter these numbers. We assume that numbers and the way these numbers are related to the surrounding text contribute to how people go about making sense of them. Our analysis is intended, in part, to form a basis for future studies on how people cognitively process numbers in everyday texts. A similar tack has been

taken by researchers studying people's understanding of graphs (Wainer, 1992), and statistics (Huff, 1954).

In the study described here, we examined some mathematical concepts (percents, fractions and averages) that have been shown to be challenging (Kouba, Brown, Carpenter, Lindquist, Silver & Swafford, 1988) which commonly appear in texts people might encounter in their daily lives - popular magazines. We ask: "What opportunities are there for individuals to demonstrate numeracy when they read everyday texts?," and address this question by analyzing the frequency and characteristics of numbers in popular magazines written for children, teenagers, and adults. Through a comparison of characteristics of numbers in magazines appropriate for the three age groups, we then discuss whether children and teenagers are being prepared, through reading these texts, to meet the numeracy demands that will be placed on them when they encounter popular magazines written for adults.

One goal of our analysis was to simply find out how frequently various rational numbers appear in everyday texts for children, teenagers and adults. A second goal was to examine some characteristics of these numbers and the ways in which they are related to their surrounding context. Specifically, we were interested in finding out the extent to which the surrounding text (both verbal and numerical) might provide information that could influence the reader's comprehension and interpretation of numbers.

We selected magazines for our study because, unlike other forms of everyday texts such as newspapers, magazines can be found which are written for children, teenagers, and adults. This allows comparisons of the numbers to be made across the three age groups. We consider

magazines to be "everyday texts" because research has shown that most people, even those classified as having low levels of literacy, read them frequently. The "Philadelphia Literacy Study" (Neubauer & Dusewicz, 1988), found that about 65% of those classified as having a low level of literacy read magazines weekly. The majority of these people reported reading magazines from one to five hours per week. Even more of those classified as having intermediate or high levels of literacy read magazines frequently: approximately 90% read magazines weekly. Again, most of these people read magazines from one to five hours per week. The Philadelphia Literacy Study showed that people who were classified as having a low level of literacy, in contrast to those classified as having intermediate or high levels of literacy, tended to be older, unemployed, belong to a minority group, have not completed high school, and earn less than $10,000 per annum. Thus, frequency of reading magazines is associated with age, employment status, ethnic group, education level, and income level.

Method

Materials

We selected a sample of 21 of the most widely circulating magazines for children, teenagers, and adults for our analysis. To select the magazines, we consulted directories reporting the circulation rates of all magazines published in North America and descriptions of the contents of each magazine (Katz & Katz, 1992; Lee, 1992; Richardson, 1991). We then selected seven of the top circulating magazines within each of the three age groups that would seem to appeal to a variety of readers. For example, within the adult category we assumed that "Time," "Newsweek," and "US News and World Report" would

have a similar readership, and from these three magazines we selected the top circulating one. A list of the magazines used in the study is presented below.

Magazines Used and Their Circulation Rates

Children's Magazines:

1) Highlights for Children (2,800,000)
2) Boy's Life (1,434,000)
3) National Geographic World (1,200,000)
4) Ranger Rick (880,000)
5) Sports Illustrated for Kids (864,656)
6) Barbie (600,000)
7) Science World (544,000)

Teenagers' Magazines:

1) Seventeen (1,750,000)
2) Trends (1,300,000)
3) Teen (1,164,000)
4) Young and Modern (925,000)
5) Careers (600,000)
6) Bop (400,000)
7) Thrasher Magazine (350,000)

Adults' Magazines:

1) Reader's Digest (16,500,000)
2) National Geographic (10,800,000)
3) Better Homes and Gardens (8,060,065)
4) National Enquirer (4,381,242)
5) Time (4,000,000)
6) Consumer Reports (3,000,000)
7) Sports Illustrated (2,900,000)

Adults' and teenagers' magazines were identified as such by the directories we consulted. Because children's magazines include those published for very young children, we adopted as a criterion for inclusion in our study only magazines that were considered suitable (Richardson, 1991) for children ranging from 6 to 8 years through 12 or 13 years. Magazines considered appropriate for a younger age group tend to contain very few numbers. The rational number concepts we

investigated are typically introduced to children in grades four and five, when they are nine or ten years of age.

We coded the middle 20 pages of one issue of each magazine, including editorials and advertisements. By coding all instances of numbers in a few of the magazines, we determined that the middle 20 pages were more representative of the numbers in the entire magazine than the first or last 20 pages. Graphs and tables were tallied separately because including all numbers in tables and graphs may have disproportionally inflated our count of rational numbers in texts, since one graph or table could contain a very high frequency of numbers. We did not analyze graphs and tables in depth for several reasons: First, we would have required a different coding scheme for these materials, and second, research on graph interpretation (e.g., Pinker, 1990) suggests that these materials are treated differently by readers than prose or advertisements (for example, it is likely that a reader would make use of a "graph schema" when interpreting a graph).

Coding Scheme

The purpose of the coding was to characterize some of the most common rational numbers in the magazines and their surrounding context. We tabulated percents, fractions, and averages in the middle 20 pages of each magazine. Graphs and tables were also tallied but were not analyzed further. The number that was focused on in each instance of coding is referred to below as the "target number." The coding scheme, described briefly below, characterized both features of the target numbers and their surrounding contexts (see Appendix A).

Frequency and type of rational number. The first level of coding consisted of simply noting whether the target number was a percent, a fraction, or an average.

Uses of rational numbers. The target numbers were further classified as expressing one of the following mathematical situations:

a) increase/decrease - E.g. "If current estimates are correct and electricity consumption increases by about 2.5 percent a year, we could be headed for real problems." (National Geographic, 1991, p. 66);

b) part/whole relation - E.g., "The nation's 113 nuclear reactors already generate 20 percent of our electricity." (National Geographic, 1991, p. 68);

c) comparison:

i) E.g., "Seventy-year-olds use 10 percent more energy than 20-year-olds who walk the same distance at the same speed, says an Arizona State University study." (Better Homes and Gardens, 1991, p. 84], or

ii) a comparison of two or more percents - E.g., "The recycling rate for plastic is only 1.1 percent, compared with 12 percent for all other recyclable materials." (National Geographic, 1991, p. 136).

"Increase/decrease," "part/whole," and "compare" are "semantic structures" that describe many of the quantitative structures that people encounter, and have previously been used successfully to classify common arithmetic word problems (Resnick, 1992).

Context: Hypothetical statements vs. statements of fact. One aspect of the texts we examined was whether numbers appeared in the context of a fact or an argument. Several researchers have recently discussed the features of texts that create the idea, for the reader, that they are dealing with a reality that is subjective and constructed, as distinct

from a reality that is objective and given (Bruner, 1986; Crismore, 1984; Feldman, Bruner, Renderer & Spitzer, 1990; Wineburg, 1991). Crismore (1984), in her analysis of history textbooks, notes that in contrast to textbook history passages, non-textbook history passages make extensive use of "metadiscourse": discourse that describes, or alludes to the author's intentions and biases. The use of metadiscourse alerts the reader to the fact that they are dealing with a world of mental states rather than of actions and facts. We hypothesized that metadiscourse may be common in magazines where numbers are often presented as evidence for claims made by individuals, and that it may play a role in readers' comprehension of a text and the numbers embedded in it.

The coding scheme distinguished numbers embedded in factual statements versus numbers embedded in hypothetical or conditional statements, claims, or opinions. The passage below illustrates the use of numbers to support a claim:

> The fast-food giant that gave us the Big Mac has been under a big *pack* attack -- criticism for its throwaway packaging. The number one offender: the plastic-foam box.
>
> In response, Mickey D's is bagging the box. Now they'll wrap their food in paper, which they say takes up 90 percent less space in landfills. The company has already started to switch in some stores. (Science World, March, 1991, p. 2)

In the passage above, "90 percent" is embedded in a claim rather than in a statement of fact. In contrast, the percents below are presented in the context of a statement of fact: "Most people who are audited wind up writing a hefty check to Uncle Sam. Only seven percent of audits result in refunds; 73 percent result in more taxes, and 20 percent produce no

change." (Reader's Digest, April 1991, p. 105). The coding focussed on the local properties of statements, for example, if a factual statement containing a percent was embedded within an argument, it was coded as a factual statement.

Context: Modifiers of numbers. Although numbers themselves are frequently used as adjectives or adverbs in a sentence (e.g., "the stocks rose 5%"), our preliminary examination of numbers in magazines revealed that they were often preceded or followed by modifiers that provided an interpretation of the number (e.g., "an astonishing 35 percent of all laws passed by Congress last session celebrated a day, week, month or decade." [Reader's Digest, 1991, p. 21], where "astonishing" modifies "35 percent."). This characteristic of the discourse surrounding numbers is of interest because it bears on the question of the extent to which readers need to process the numbers themselves. Although this would ultimately have to be determined by research on the cognitive processes readers engage in while reading texts containing numbers, our analysis was designed to reveal whether the surrounding text frequently contains a modifier which offers the reader a ready-made interpretation of the number. This would suggest that readers can rely on such interpretations rather than interpreting the numbers.

We coded the presence of a part of speech, such as an adjective, in the immediate context which served to modify the target number. Only modifiers that immediately preceded or immediately followed the target number were coded.

Context: Relation of target number to other quantitative expressions. We wished to examine the ways target numbers are related to other quantitative expressions, and on the basis of this, to characterize

these relations. A related quantitative expression could be verbal (e.g., "... giving them average salaries of $40,496, second highest in the nation." [Time, July 1991, p. 24], where "second highest" is the verbal expression the target number, "average of $40,496," is related to). A related quantitative expression could also be numerical (e.g., "... only about 12% of the inhabitants of the U.S. were enslaved in 1860, but almost two-thirds of the Russian empire's people were serfs at the time of emancipation" [Time, July 1991, p. 32], where "two-thirds" is the numerical expression the target number, "12%," is related to). If the target number was related to a quantitative expression, we then asked whether the target number and the quantitative expression to which it was related denoted the same referent (first example above) or different referents (second example above). A third possibility was that the target number was related to either the whole quantity of which it is a part, or to another part of this whole (e.g., "A typical 15-story building has about 400 explosive charges in it," says Loizeaux. "Ninety percent of the charges are planted in columns on the bottom floor." [Science World, March 1991, p. 10]). In this example, "90 percent" represents part of the whole "400 explosive charges."

Finally, if the target number was related to another quantitative expression, we classified the quantitative expressions as follows: a verbal statement, integer, fraction, percent, or other type of quantity. Verbal statements included statements about relative size (e.g., "big," "most," "a few"), multiplicative statements (e.g., "doubled"), and ordinal statements (e.g., "second highest"). The category "other" included any quantitative expression that did not fall into the categories above.

Reliability. One coder coded all the numbers in 20 pages of each magazine, and another coder coded 25% of the numbers. The agreement between the two raters, calculated on all the coding categories for 25% of the numbers, was 90.10%.

Results and Discussion

Frequency of Rational Numbers

Numbers were tabulated separately for articles and advertisements, however, because the distributions of types of numbers and their characteristics were similar for articles and advertisements across magazines for the three age groups, they were collapsed and are discussed together.

In general, there were far more rational numbers in the adults' magazines than in either the children's or teenagers' magazines (see Table 1). Adults' magazines contained approximately

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Insert Table 1 about here

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two to ten times as many rational numbers (depending on the rational number concept) as did the children's and teenagers' magazines. Whereas an average of only 2.71 (*SD* = 1.50) and 5.71 (*SD* = 10.84) of these rational numbers appeared in 20 pages of the children's and teenagers' magazines, respectively, an average of 16.86 (*SD* = 14.86) appeared in 20 pages of the adults' magazines. The most dramatic difference in the frequencies of rational numbers was found in the number of percents: Whereas children's and teenagers' magazines contained approximately one and three percents per 20 pages,

respectively, the adults' magazines contained ten percents, or one every two pages.

The low frequency of some of these mathematical concepts in children's magazines is understandable; for example, "percent" is introduced as a mathematical concept around the fifth grade, and the children's magazines in our study were aimed at third through sixth graders. However, because percents are usually covered from grades five through seven, teenagers should have the mathematical background to understand percents, yet we found very few percents in teenagers' magazines. Similarly, few fractions appeared in children's and teenager's magazines relative to the number found in adult's magazines, yet fractions are covered thoroughly in grades four through six.

A tally of all graphs and tables which contained rational numbers shows that there was a total of one table altogether in the coded sections of the seven children's magazines, four tables and one bar graph in the teenagers' magazines, and three tables and two bar graphs (one of which was integrated into a map) in the adults' magazines. A tally of <u>all</u> graphs and tables, including those which contained numbers other than rational numbers, indicates that there were two tables in the children's magazines, five tables and one bar graph in the teenagers' magazines, and four tables, four bar graphs, and one pyramid diagram (which was used to show quantities) in the adults' magazines. All graphs and tables in the sections of the teenagers' magazines we examined appeared in one magazine, <u>Trends</u>. Those in the adults' magazines were more distributed, and appeared in four different magazines. The number of tables in teenagers' and adults' magazines was

similar, but many more graphs appeared in the adults' magazines than in the teenagers'.

Uses of Numbers

As discussed above, numbers were classified as describing an increase or decrease, a part/whole relation, a comparison, or a comparison of two or more percents. A preliminary analysis revealed that fractions and averages were almost always used to describe part/whole relations, and we therefore focussed on only percents in this analysis. The most common use for percents in all three groups of magazines was in describing part/whole relations (see Table 2).

Insert Table 2 about here

In the children's magazines, 75% of the percents were used for this purpose, whereas in the teenagers' and adults' magazines, only about 50% of the percents were used in a part/whole context. Research with sixth and eighth grade students has suggested that percents used in a part/whole context are easier for children to comprehend (Joram, Raghavan & Resnick, 1991), and the use of percents in children's magazines seems to reflect this. The second most common use of percents was for describing increases or decreases: a quarter of the percents in children's magazine, and approximately one-third of the percents in teenagers' and adults' magazines were used for this purpose. Percents were used less frequently to make both types of comparisons in teenagers' and adults' magazines than they were for expressing increases and decreases or part/whole relations, and

percents were not used to compare quantities at all in the coded sections of the children's magazines. A small number of comparisons of percents were found in teenagers' and adults' magazines, however, only adults' magazines contained the first kind of comparison statement (e.g., "Seventy-year-olds use 10 percent more energy than 20-year-olds....").

Although the frequency of percents differed in the teenagers' and adults' magazines, as discussed above, the distribution of uses (increase/decrease, part/whole, compare) was similar for these two groups but distinct from that found in the children's magazines.

Hypothetical Statements vs. Statements of Fact

All instances of fractions, percents and averages were coded in terms of whether they occurred in the context of a statement of fact or in the context of a hypothetical or conditional statement, claim or opinion (the latter are all referred to here as "hypothetical statements"). We found that the children's magazines contained the lowest proportion of factual statements relative to hypothetical statements (68% factual, 32% hypothetical). Teenagers' magazines contained proportionally more factual statements to hypothetical statements than the children's magazines (78% factual, 22% hypothetical), and the adults' magazines had the highest proportion of factual statements relative to hypothetical statements (92% factual, 8% hypothetical). Although the mean number of hypothetical statements in the three groups of magazines is very similar (M = .86 [SD = 1.21]; M = 1.29 [SD = 3.40]; M = 1.29 [SD = 1.80], respectively), there is large increase in the mean number of factual statements, from children's to

adults' magazines (M = 1.86 [SD = 1.77]; M = 4.43 [SD = 7.96]; M = 15.57 [SD = 13.15], respectively). Focussing on the mean number of hypothetical statements in the three age groups, these findings suggest that children and teenagers are exposed to numbers in the context of arguments, claims, etc., in popular texts about as often as are adults.

The small number of hypothetical statements in magazines for all three age groups is surprising, and suggests to us that our coding scheme may need to be revised to take into account the global context of numbers. That is, if a number appeared in a factual statement that itself was embedded in an argument, then the coding scheme would identify the context of the target number as an argument.

Modifiers.

We tabulated the frequency of rational numbers that were modified by an adjective or adverb in the immediate context. Whereas only 5% (M = .14, SD = .38) and 7.5% (M = .43, SD = .79), respectively, of the numbers in the children's and teenagers' magazines were preceded or followed by a modifier, 14% (M = 2.43, SD = 1.90) of the rational numbers coded in the adults' magazines were modified by a part of speech such as an adjective. Although 14% does not represent a large proportion of the numbers that appear in the adults' magazines, these data suggest that there is relatively more interpretation of numbers provided by authors writing for the adults' magazines than by those writing for children's and teenagers' magazines.

Overall, these findings suggest that authors do not provide a great deal of interpretation of numbers in their immediate context, and that numbers are usually allowed to speak for themselves. Again, it is possible that a considerable amount of interpretation of numbers occurs

in texts, but that our coding scheme did not pick it up because we coded only modifiers that immediately preceded or followed the target numbers. It is very common for passages in texts that contain numbers to begin with a sentence that expresses the gist of the passage in natural language, as in the example below:

> DRUGS DOWN
>
> More and more kids are saying no to drugs! According to a new study conducted by the University of Michigan, 33 percent of high school seniors have taken at least one illicit drug during the past year -- *down* from a peak of 54 percent in 1979. A drug-by-drug breakdown came up with similar stats: Twenty-seven percent of seniors reported using marijuana the year before, compared to a 1979 high of 51 percent.
>
> (Seventeen, 1991, p. 41)

At any rate, the findings suggest that one of the numeracy demands of everyday texts is evaluating a number apart from modifiers in the immediate context. In the following example, discerning readers might ask themselves whether the increase described is really as substantial as the word "jumped" suggests: "Between 1988 and 1990 the proportion of first-time mothers who were 30 or older jumped from 16.9 percent to 18.1 percent." (American Baby, June 1993, p. 6). Taking a skeptical stance to numbers in the text may lead a reader to postpone accepting an author's claim until more information on the topic becomes available.

Contexts for Rational Numbers

We examined the contexts in which rational numbers appeared and coded whether the target number was related to another quantitative

expression, either verbal or numerical (see Table 3). We found that in the children's magazines, target numbers were related to other quantitative expressions 42% of the time, in teenagers' magazines about 55% of the time, and in adults' magazines, about 59% of the time. Thus, the percentages of target numbers that were related to other quantitative expressions is similar in the three age groups of magazines. Clearly, rational numbers are often related to other types of quantities in popular texts for all age groups; numbers are not presented only in isolation.

We also coded whether the target number was related to a different quantity, the same quantity, another part of the whole of which the target number was part, or the whole itself (the latter two are referred to as "part/whole"). Looking at Table 3, we can see that the types of relations that characterize the target numbers and their surrounding contexts are very similarly distributed in the children's and teenagers' magazines.

Insert Table 3 about here

All target numbers were related to either different quantities or to part/whole quantities in these two groups of magazines and none were related to the same quantities. However, in the adults' magazines, the relations that characterize target quantities and their surrounding quantitative context are very different: Target numbers were almost never related to part/whole quantities, and were related to quantities referring to the same referent about one-third of the time.

We categorized the type of quantitative expressions the target numbers were related to. In magazines for all three age groups, the target number was most often related to an integer or to a percent (see Table 4).

Insert Table 4 about here

Focussing on just these types of quantities, in the children's magazines, target numbers were related to integers three-quarters of the time and to percents one-quarter of the time. In both the teenagers' and adults' magazines, target numbers were related to integers about one-third of the time, and to percents about one-half of the time. Teenagers' magazines, although containing few rational numbers, resembled adults' magazines in the kinds of quantities rational numbers were related to.

Conclusions

Numbers in Everyday Texts: The Transition from Children's Magazines to Adults' Magazines

The results of this study show that adults are frequently presented with rational numbers in popular magazines. These numbers often form part of complex mathematical discourse structures in which several numbers are related, and frequently refer to the same referents. Our examination of the uses of percents shows that in adults' magazines, percents were often used to express increases and decreases as well as part/whole relations. In contrast, the children's magazines we examined contained far fewer rational numbers than the

adults' magazines and most of these numbers were presented in a part/whole context. When rational numbers in the children's magazines were related to other quantities, it was most often to an integer rather than to another rational number.

In many ways teenagers' magazines seem to fall short of the kinds of texts that we might imagine would form a transition from children's texts to those of adults. For example, relatively few rational numbers appeared in the teenagers' texts. In other ways, numbers in teenagers' magazines resemble those found in adults' magazines: Rational numbers in teenagers' magazines were not so closely tied to the part/whole schema as were those found in children's magazines. In addition, when rational numbers in teenagers' magazines were related, they were much more likely to be related to a percent than to an integer.

Rational Numbers in Textbooks

The results of our study suggest that there is a major transition to be made between children's and adults' magazines with respect to rational numbers, and we wanted to find out if school instruction would help ease this transition. To address this issue, we examined the treatment of percents, fractions, and averages in the most recent teachers' editions of three major textbook series, from grades four through eight (Addison Wesley, 1993; Houghton-Mifflin, 1992; ScottForesman, 1994).

Our inspection of textbooks revealed that the series varied a great deal in terms of their efforts to give students exposure to, and practice interpreting rational numbers as they appear in everyday texts. One series made considerable effort to provide students with opportunities to discuss and interpret numbers in service of what we

have called "informational numeracy." For example, students were instructed to locate percents in newspapers and magazines, and to discuss their meaning with peers, or to write a paragraph explaining how they were used. This series also provided many exercises in which students were directed to discuss the meaning of percents that appeared in statements such as "A tomato is 95% water." Fractions were also presented in the context of everyday materials in this series: for example, one exercise showed a picture of a stock market report in a newspaper and asked students to discuss the meaning of the fractions; other exercises made use of recipes. The misleading uses of averages were discussed using articles taken from a school newspaper to illustrate.

The emphasis in the other two series seemed to be on useful, rather than on informational numeracy. Exercises were found in which rational numbers were embedded in texts that were authentic, such as sales advertisements, however, students were almost always asked to perform computations with the numbers embedded in these texts rather than to interpret them. For example, cereal advertisements were presented, and students were asked to perform calculations to determine which was the best buy. Although infrequent, some exercises were found in these two series which seem relevant to developing informational numeracy skills. For example, in a chapter on statistics, one series presented exercises on the misleading uses of percents and averages in the media. In another exercise, teachers were instructed to have their class find news or sports articles containing percents, and to discuss why data is described with percents rather than with actual values. Students were also asked to match a phrase like "discount percent" with

a numerical example, like "25% off," selected from a list of numerical examples. Although these exercises are innovative and potentially important for promoting informational numeracy, they were few and far between.

Despite the variation in the textbooks series' provision of opportunities for students to interpret rational numbers in authentic-looking texts, all three series provided students with a great deal of practice interpreting graphs and tables, understanding the misleading uses of graphs, and the appropriate use of different kinds of graphs.

Based on our informal examination of textbooks, it seems that some students may not receive much instruction on the interpretation of rational numbers via textbooks in their mathematics classrooms. This is particularly problematic for teenagers because they have to make the transition from children's texts, in which few difficult numbers are presented, to adults' texts, in which difficult rational numbers are very common. Again, because research has not yet been carried out on numeracy instruction in classrooms, our analysis of textbooks is only suggestive of the nature of this instruction. However, if treatment of numeracy in textbooks is indicative of the way in which numeracy is treated in the classroom, we can recommend several areas for instructional improvement. We would add to the exercises we found in all of the series, practice interpreting numbers which appear in the kind of complex discourse often found in magazines, where numbers are related to each other, are sometimes preceded or followed by adjectives and adverbs which modify them, and are used as evidence for claims and arguments. In combination with computation exercises that involve rational numbers, practice interpreting numbers embedded in complex

discourse as a task in its own right, where the goal is to comprehend and interpret information in a passage rather than to solve a specific problem, would provide students with the opportunity to cultivate skills they need in order to both comprehend and interpret numerical concepts in printed texts.

Promoting Numeracy Through Interpreting Everyday Texts

In order to improve the numeracy skills of students, discourse communities beyond those found in schools and textbooks may have to be altered. A change in the kinds of numbers students are exposed to in everyday texts and other media may be required, in addition to effecting changes in the skills students bring to this informal task. Everyday texts may provide an as yet underexploited avenue to promote numeracy. We suggest that children's and teenagers' texts can support the development of numeracy in several ways. First, they could more frequently present challenging number concepts like percents and fractions. Second, they might provide students with information on how to interpret these concepts. Finally, texts might be carefully designed so that the text surrounding difficult numbers will support readers' comprehension, for example, by providing information that is redundant or complementary to the numerical concepts presented. We found one example of a popular magazine aimed at children which already promotes numeracy in an active way: Sports Illustrated for Kids often contains a section called "Numbers," where difficult numerical concepts that frequently appear in the magazine (such as a batting average) are explained to children.

The characteristics of rational numbers in magazines we identified can be thought of as opportunities for numeracy. However, it is not

possible to draw conclusions about actual numeracy practices based on what we have discovered about text characteristics. For example, many people may simply ignore numbers in texts, and this is sometimes made possible by the provision of redundant linguistic information. For example, as pointed out above, in the passage from Seventeen magazine, a reader could garner the "gist" of the numbers in the passage by simply reading the first sentence. Future research is needed which carefully examines the cognitive processes people engage in when reading everyday texts which contain numbers, and identifies textual features that might provide effective learning supports for students.

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Appendix A - Coding Scheme

1) Record page number and quadrant of the page on which target number appears.

2) Article or Advertisement: Note whether target number appears in an advertisement or an article.

3) Type of Number: Record whether number is a percent, fraction, or average; include short verbatim record of instance and surrounding text.

4) Uses of Percents: If target number is a percent record the mathematical situation it expresses:

   I/D - increase or decrease

   PW - part/whole

   C1 - compare

   C2 - compare two or more percents

5) Hypothetical or Factual Statement:

   Hypothetical - target number appears in the context of an argument, opinion, hypothetical or conditional statement; these statements are often identified by the presence of mental state terms, such as "She thinks ... is the case."

   Factual - the number is used in context of a straightforward assertion of information.

6) Modifier (Yes/No): Note whether target number is immediately preceded or followed by an adjective or adverb that modifies it.

7) Relation to Other Quantitative Expressions (Yes/No): Note whether target number is related to other quantitative expressions.

8) Type of Relation: If the target number is related to a quantitative expression, note whether both the target number and related number refer to:

S: the same referent (e.g., "15%, or 37 million people"),

D: different referents

PW: an expression that represents the whole of which the target number is a part (e.g., "15% of all people in the U.S., that is, 246.6 million people", where 15% is the target number and 246.6 is the whole quantity of which 15% is a part)

9) Type of Related Quantitative Expression:

I - integer

F - fraction

P - percent

V - verbal statement that is quantitative in meaning, e.g., "least" (also includes: multiplicative statements, e.g., "doubled", and ordinal statements, e.g., "second highest")

O - other (any quantitative expression that does not fall into one of the categories above)

Table 1

Mean Frequency (SD) of Types of Rational Numbers (per 20 pages) Appearing in Magazines by Age Group

Age Group	Mean Number of Related Rational Numbers	Type of Relation		
		Fraction	Percent	Average
Children's Magazines	2.72	1.29	1.14	.29
		(1.25)	(1.46)	(.49)
Teenagers' Magazines	5.71	1.43	3.14	1.14
		(1.81)	(7.08)	(2.61)
Adults' Magazines	16.86	4.86	10.00	2.00
		(4.06)	(10.42)	(2.83)

Table 2

Mean Use (SD) of Percents by Age Group

Age Group	Mean Number of Percents	Use			
		Increase/ Decrease	Part/ Whole	Compare	Compare (2+ %s)
Children's Magazines	1.14	.29	.86	.00	.00
		(.49)	(1.07)	(.00)	(.00)
Teenagers' Magazines	3.14	1.00	1.57	.00	.57
		(2.24)	(3.36)	(.00)	(1.51)
Adults' Magazines	10.00	3.57	5.14	.57	.71
		(4.61)	(5.34)	(.79)	(.95)

Table 3

Mean Number (SD) of Context Relations of Rational Numbers by Age Group

Age Group	Mean Number of Related Rational Numbers	Type of Relation		
		Different	Same	Part/Whole
Children's Magazines	1.14	.71	.00	.43
		(1.11)	(.00)	(.79)
Teenagers' Magazines	3.14	1.71	.00	1.43
		(2.63)	(.00)	(3.78)
Adults' Magazines	9.86	6.71	3.00	.41
		(6.68)	(3.51)	(.38)

Table 4

Mean Frequency (SD) of Types of Quantities Target Numbers are Related to by Age Group

Age Group	Mean Number of Related Rational Numbers	Types of Quantities Target Numbers Related To				
		Verbal	Integer	Percent	Fraction	Other
Children's Magazines	1.15	.00	.86	.29	.00	.00
		(.00)	(1.21)	(.76)	(.00)	(.00)
Teenagers' Magazines	3.14	.00	.86	1.57	.71	.00
		(.00)	(1.57)	(4.16)	(1.25)	(.00)
Adults' Magazines	9.86	.57	3.00	4.14	.29	1.86
		(1.13)	(3.56)	(.6.44)	(.49)	(2.12)